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TARIFFS VS. QUOTAS WITH ENDOGENOUS QUALITY

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ABSTRACT

This paper analyzes some aspects of the effects of trade restrictions (such as tariffs, quotas and quality controls) and their desirability when the quantity of the imported good is endogenous, and the foreign producer is a monopolist. It uses a fairly general model based on the work of Spence and Sheshinski.

A crucial determinant of the direction of these effects is shown to be the valuation of increments in quality by marginal consumers, relative to that of all consumers on average. A way of comparing infinitesimal equivalent policies is developed and used to compare import equivalent policies. For reasonable characterizations of demand - tariffs are shown to dominate quotas on the basis of their revenue effects alone, while quotas are shown to dominate tariffs on the basis of their quality effects alone. Also, quality controls are shown to dominate both tariffs and quotas on the basis of revenue effects alone for reasonable characterizations of demand. Some special cases are also analyzed, including the case where demand is modelled along the lines of Swan - and only services of the good produced matter to consumers.

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TARIFFS VS. QUOTAS WITH ENDOGENOUS QUALITY

Introduction

This paper analyzes some aspects of the effects of trade restrictions and their desirability when the quality of the imported good(s) is endogenous, and the foreign producer has market power.

Typically, a firm must decide on the number of products produced and their qualities. By introducing many qualities a producer could target products to groups of consumers and make greater profits by doing so. However, there are likely to be significant costs associated with producing many qualities,[1] and to this extent the producer would want to produce one product targeted to all consumers.

This discussion suggests two aspects of a producer's choice of potential interest. The first relates to how the producer when faced with diverse consumers chooses one good which is best suited to the group as a whole, and how this aspect of his choice is affected by trade restrictions. The second relates to the pricing of a product line -- and the effects of trade restrictions on such pricing policies. I will deal with the first in this paper. The second is dealt with in a companion paper. (See Krishna (1984).)

Existing work in the trade literature on the effects of trade restrictions with endogenous quality focuses mainly on the nature of these effects in a competitive world. The specifications of the models are therefore particularly suited to the perfectly competitive paradigm. Unfortunately, they also tend to obscure some significant aspects of firm behavior in an imperfectly competitive world.

Previous work by Rodriguez (1980) and Santoni and Van Cott (1980), for example, deals with these questions in the context of a specific model (associated with Swan (1970)), where demand is for services of the good only, and higher quality goods are more durable. This specification simplifies the analysis considerably. As only the quantity of services matters to the consumer, questions regarding the composition of the product line, or those regarding targeting products to groups of consumers do not arise at all! Only one quality is produced -- that which minimizes the unit cost of producing services when the optimal level of services is being produced. In their model, quotas cause quality upgrading, while ad-valorem tariffs do not. Although this accords well with empirical work (see Turner (1983), Feenstra (1982)), their reason is related to cost rather than demand conditions. An alternative reason, based on demand conditions, emerges from my analysis. This reason is related to quality being chosen so that it is best suited to all consumers who are served.

Hence, it seems fair to argue that while the effects of trade restrictions with endogenous quality have been studied, the issues are far from well understood, especially in the context of imperfectly competitive markets.

An advantage of the Swan model is that the comparison of various policies can be made with the aid of a two-dimensional diagram. This is not possible in a more general model. Hence, the techniques used in this paper cannot be only diagramatic. In this paper, I develop a simple way to compare various infinitesimal policies. These comparisons are illustrated using diagrams whenever possible.

In the first part of this paper, I consider the effect of trade restrictions when the market structure is that of foreign monopoly, and only one quality is produced -- so that the product must be targeted to all consumers. Quality is modeled in a general way as a factor that raises the willingness to pay for a unit -- as in Spence (1976) and Sheshinski (1976). In contrast to the results obtained using the Swan specification (which is a special case of this specification), quotas do not necessarily raise qualities and tariffs do not leave the quality of imports unaffected. The effect on quality of a quantitative restriction is shown to depend on the valuation of quality increments by the marginal consumer as compared to the average valuation of quality increments by all consumers. If the marginal valuation of a quality increment exceeds the average, quality downgrading occurs as the result of the quota. If the reverse is true, quality is upgraded in response to the quota. The intuition behind this result is straightforward. A binding quota removes the marginal consumer from the market. If this consumer valued quality less (more) than the average consumer, the benefit to the monopolist of raising quality exceeds (falls short of) the cost of raising quality and it is in the monopolist's interest to raise (lower) quality.

Similarly, the effect of a minimum quality level is to raise (lower) output, if the valuation of an increment in quality by the marginal consumer exceeds (falls short of) that of the average.

An ad-valorem tariff affects the monopolist's decision on both output and quality and this complicates the result. If the valuation of an increment in quality by the marginal consumer is more than the average, quality is downgraded, but the reverse is no longer true.

In the second section the effect on welfare of any restriction is decomposed into its components namely that via output, quality, and revenue. Irrespective of whether quotas raise or lower quality, their welfare effects via quality alone are shown to be beneficial. When import equivalent policies are compared, the ranking of policies is shown to depend on whether quotas raise or lower quality and on whether tariffs lower the volume of imports or not. In the "normal" case, when quotas raise quality and tariffs lower imports, tariffs dominate quotas on the basis of their quality effects alone, while quotas dominate tariffs on the basis of their revenue effects alone. It is also shown that quality controls dominate both tariffs and quotas on the basis of quality effects alone, as long as a tariff reduces imports.

Other definitions of equivalence - such as revenue equivalence or expenditure equivalence can also be dealt with in my framework, and they lead to similar results. Their analysis is omitted in the interests of brevity.

Section 1

The Effects of Trade Restrictions

The analysis in this paper is confined to a partial equilibrium setting. There is one foreign producer of the product, who acts as a monopolist. The producer is assumed to set a price and a quality level (or equivalently, an output and quality level) which the consumer takes as given. Quality is modelled as a uni-dimensional variable, q. In order to focus on the role of demand conditions in this paper, I assume that there is a constant marginal cost, $C(q)$, of producing a unit of output of quality q. x is total demand. The inverse demand function facing the producer is given by $P(x,q)$. $P_q(x,q)$ is assumed positive. Quality is thus modelled in a general way, as a factor that increases the willingness to pay for any given output level.[2]

The monopolist's choice of x and q will be given by the solution to the profit maximizing problem:

$$\text{(1.1)} \qquad \underset{x,q}{\text{Max}}\ \Pi(x,q) = (P(x,q) - C(q))x \ .$$

Assume that a unique interior solution exists to this problem. Then, first order conditions for a maximum require that:

$$\text{(1.2)} \qquad \Pi_x(x,q) = P_x(x,q)x + P(x,q) - C(q) = 0 \ ,$$

and

$$\text{(1.3)} \qquad \Pi_q(x,q) = \left[P_q(x,q) - C_q\right]x = 0 \ .$$

The second order conditions for a maximum are given by the Hessian "H" being negative definite at (x^*,q^*), the solutions to (1.2) (1.3), where, "H" at (x^*, q^*) is given by:

$$(1.4) \quad \text{"H"} = \begin{bmatrix} (2P_x + xP_{xx}) & (P_{xq}x) \\ (P_{xq}x) & \{(P_{qq} - C_{qq})x\} \end{bmatrix} = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix} .$$

The effect, on quality, of a quantitative restriction may be examined by reformulating the problem set up in (1.1) as a maximization problem subject to the constraint that $x \leq \bar{x}$. Simple comparative statics on q with respect to $\bar{x}$, evaluated at $\bar{x} = x^*$, would indicate the effect of a "slightly restrictive" quota. This procedure gives the result that:

$$(1.5) \qquad \left.\frac{dq}{d\bar{x}}\right|_{\bar{x}=x^*} = \frac{-P_{xq}}{(P_{qq} - C_{qq})} .$$

This may be easily interpreted with reference to Diagram 1.1. Equation (1.2) gives the level of x that maximizes profits for each given q . The locus of such points is traced out by $x(q)$ in Diagram 1.1. Similarly, equation (1.3) traces out the level of q that maximizes profits for each given level of x . $q(x)$ is the locus of such points. x^*,q^* are given by the intersection of $x(q)$ and $q(x)$. Notice that as H_{11} , H_{22} , elements of the Hessian "H", are negative, the sign of the slopes of $x(q)$ and $q(x)$ at x^*,q^* are the same as the sign of P_{xq} . In addition, as $|H| > 0$, $x(q)$ is steeper than $q(x)$. The restriction on x essentially suspends equation (1.2),

replacing it by the vertical line $x = \bar{x}$. Lowering $\bar{x}$ from x^* thus moves the equilibrium in the direction of the arrows in Diagrams 1.1(a) and (b). This raises quality if $P_{xq} < 0$, and lowers it if $P_{xq} > 0$. If P_q is monotonic in x, then $P_{xq}(\hat{x},\hat{q}) \lesseqgtr 0$ as $\int_0^{\hat{x}} P_q(v,\hat{q})dv - P_q(\hat{x},\hat{q})x \gtreqless 0$. This is because of the usual relation between marginals and averages. $\frac{1}{\hat{x}}\int_0^{\hat{x}} P_q(v,\hat{q})dv$ is the average valuation of an increment of quality, while $P_q(\hat{x},\hat{q})$ is the valuation of an increment in quality by the marginal consumer. The following interpretation of P_{xq} (as given by Spence) is illuminating in this context. In Spence's words:

> "P_{xq} is the change in P_q as one moves down the spectrum of consumers ordered by their willignness to pay. If $P_{xq} < 0$, the marginal value of quality falls as absolute willingness to pay falls. When this is true, the average value attached to quality exceeds the marginal consumers valuation."[3]

Lowering output removes the marginal consumer from the market. If the marginal consumer values quality less than the average value attached to quality, it is in the interest of the monopolist to raise (lower) quality, as shown by equation (1.5).[4]

The effects of <u>minimum</u> quality standards may be analyzed in an identical fashion. The comparative statics calculations show that:

$$\frac{dx}{d\bar{q}} = \frac{-P_{xq}x}{(2P_x + xP_{xx})} \quad . \tag{1.6}$$

This expression has the same sign as P_{xq}. If $P_{xq} < 0$, as $\bar{q}$ rises, x falls. This result may be interpreted as follows. The increase in $\bar{q}$ makes serving the marginal consumer less profitable as he does not

value increments in q as highly as the average, and so output falls with increases in q.

Unlike the effects of a quota and quality control, which in effect suspended one equation, an ad-valorem tariff affects the position of both $x(q)$ and $q(x)$. The problem facing the producer is

$$\text{(1.7)} \qquad \underset{x,q}{\text{Max}} \; (P(x,q)(1-t) - C(q))x \; .$$

Simple comparative statics yield:

$$\text{(1.8)} \qquad \frac{dx}{dt} = \frac{(P_x x + P)(P_{qq} - C_{qq})x - P_{xq} x \, P_q x}{|H|}$$

Second order conditions ensure that if $P_{xq} > 0$, $\frac{dx}{dt} < 0$. If $P_{xq} < 0$, the sign of $\frac{dx}{dt}$ is indeterminate.

Similarly,

$$\text{(1.9)} \qquad \frac{dq}{dt} = \frac{(2P_x + P_{xx}x)xP_q - (P_x x + P)xP_{xq}}{|H|} \; .$$

Again, if $P_{xq} > 0$, $\frac{dq}{dt} < 0$, and if $P_{xq} < 0$, the sign of $\frac{dq}{dt}$ is ambiguous. Diagrams 1.2(a) and (b) illustrate the effect of an increase in t. "E" is the free trade equilibrium. "A" is the equilibrium with a tariff. It is obvious from the diagram that at least one of $\frac{dx}{dt}$ and $\frac{dq}{dt}$ must be negative if $P_{xq} < 0$.

The effects of a specific tariff are qualitatively the same as those of a quota. The specific tariff, s, has producers maximizing profits given by:

$$\Pi(x,q,s) = (P(x,q) - C(q) - s)x \ . \tag{1.10}$$

Doing the required comparative statics yields:

$$\frac{dx}{ds} = \frac{(P_{qq} - C_{qq})x}{|H|} < 0 \ , \tag{1.11}$$

and

$$\frac{dq}{ds} = \frac{-xP_{xq}}{|H|} \ , \tag{1.12}$$

so a specific tariff always lowers output. It raises quality if $P_{xq} < 0$, while lowering it if $P_{xq} > 0$.

Having derived the effects of different kinds of restrictions on the quality and output choices of a monopolist, it is appropriate to relate the results in this section to previous work in the area.

Trade theorists, in discussing the effect of trade restrictions on quality, have focused attention on models of perfect competition, and on the demand characterization associated with Swan (1970). The assumption in such models is that demand is essentially for services produced by the goods, and higher quality goods have greater durability and hence produce more services. As a result, the questions regarding product lines and choice of characteristics do not arise at all. Only the quality that minimizes cost per-unit of services will be produced. Quality choice is completely determined by cost conditions. This characterization is somewhat unappealing as it assumes that the quality dimension cannot be used by the monopolist in his interests.

An ad-valorem tariff does not affect this choice of quality, but a quota does in the Swan model. The intuition behind this result is as follows. The quota,

when binding, can be thought of as having a shadow price associated with it. The effect of raising q on cost per unit of a service is, to the first order, equal to zero, as cost per unit of a service is minimized. However, an increase in q lowers the shadow price of the constraint, as it makes the constraint less binding. Thus, on the margin, raising q in response to a quota is profitable. Tariffs do not raise quality as the cost minimization problem is unaffected by a tariff.[5]

There are two advantages to using a more general framework. First, it shows that the monopolist, with two characteristics to set so as to maximize profits, will use both to extract as much surplus from consumers as possible. Any restriction changes the optimal mix between the use of the two, and how this mix changes depends on demand characteristics as shown earlier.

The second advantage of the approach is its generality. The approach of Rodriguez (1979) and Santoni and Van Cott (1980) emerges as a special case. Though they only consider the case of competition, it is easy to extend some of their results to the monopoly case, as is done later.

The results of this section are crucial to the analysis of the next section. In the next section, tariffs, quotas and quality controls which lead to an equal infintesimal reduction in imports are compared.

Section 2

Import Equivalent Restrictions

2.1 Preliminary Remarks:

This section compares ad-valorem tariffs, quotas, and quality controls that achieve a given slight reduction of imports. A few preliminary remarks are in order before we start the analysis.

I will assume that any desired quality level can be ensured. It is assumed that the administrative machinery can set both minimum and maximum quality standards. In the same spirit, tariffs are not confined to being positive. It is possible for a tariff to raise imports, and decreases in physical imports may require subsidies.

2.2 The Sale of Licenses:

In order to be able to compare tariffs and quotas, it is necessary to specify how import licenses are distributed, who appropriates the rents, and what these rents are. This is easy in the case of competition, where the difference between domestic price (as determined by market supply with the quota and market demand), and the foreign price, determines the level of rents. This difference is the price of a license auctioned to competitive suppliers.

In the case of foreign monopoly, no foreign supply curve exists, with or without any restrictions present. It is not obvious how much would be paid for a license, and what ensures that a license is used. The problem is that of specifying how the sale of license affects the

profit maximization problem perceived by the monopolist. One interpretation of the specification that follows is that the government sets a price for a license which is sold to foreign producers who take this price as given and beyond their control. A license allows the foreign producer to export one unit of a good of any quality it desires. Thus, a license acts exactly like a specific tariff. If the government wishes to set a quota at the level R, it would implement it by setting the license price p^L such that the foreign monopolist chooses to sell only R.

This is portrayed in Diagram 2.1(a) and (b). Diagram 2.1(a) shows the optimal choice of x for a given q and 2.1(b) depicts the optimal choice of q for a given x. The former is characterized by the familiar marginal cost equals marginal revenue condition. The latter is characterized by the inverse demand function being tangent to the cost function. These are implications of the first order conditions for a maximum. $MR(x,q^f)$ is the marginal revenue function corresponding to the inverse demand function $p(x, q^f)$. x^f and q^f are the profit maximizing output and quality choices for the monopolist under free trade.

When imports are restricted to be R, q^R is the profit maximizing quality choice for the monopolist as shown in Diagram 2.1(b). If q^R is the quality choice, $P(x,q^R)$ is the inverse demand function facing the monopolist in Diagram 2.1(a), and $MR(x,q^R)$ is the corresponding marginal revenue curve. If a license price of p^L is set, the monopolist would wish to produce R. Thus, the quota at level R can be

implemented by setting a license price of P^L . R is the profit maximizing choice of output on the part of the monopolist, given a license price of P^L , his beliefs on how he can affect the price P^L and a quality level of q^R . q^R is the profit maximizing quality choice when output is R .

This assumption on the beliefs of the foreign monopolist is not the only possible assumption that could be made. The foreign firm might believe that it can influence the price of a license. In this case, the relative strengths of the monopolist and the government would determine what part of the rents were appropriated by the monopolist. If the monopolist refused to purchase any licenses and the government wished to have the quota level actually imported, the only price it could change for a license would be zero. All rents would accrue to the foreign firms under this assumption. There are two reasons why I do not choose to make this assumption. Firstly, the relative strength of a government as compared to a firm make the assumption implausible. In addition, it is often argued that in practice, tariffs generate revenues but quotas do not as licenses are rarely sold. I compare tariffs and quotas when the best case for quotas is made. I show that even on these terms, revenue effects of a tariff tend to dominate those of a quota. The assumption that quotas generate no revenues would needlessly bias the welfare comparisons to follow in favor of tariffs.

Once again, notice that under this assumption on the beliefs of the monopolist, the revenue from the sale of licenses is identical to the revenue from a specific tariff, s , that lowers imports to the level

of the restriction. If fact, all the effects of the quota may be associated with those of the specific tariff, s, that implements the quota.

2.3 Tariffs vs. Quotas:

In order to compare different kinds of restrictions, it is necessary to specify the national welfare function. I will assume that the demand side can be represented by a utility maximizing aggregate consumer who has rights on all profits generated by competitive domestic producers of a numeraire good. The profits generated by production of the imported good accrue to foreign nationals. The weight given to revenue in the welfare function may be less than one if there were considerable administrative costs of collecting the revenue, or if government essentially wasted part of revenue raised. Similarly, if the government cannot undertake policies in the national interest due to revenue considerations, this weight may exceed one. The national welfare function, when the specific tariff "s" is levied is defined by:

$$W(x,q,s) = [U(x,q) - P(x,q)x] + \alpha sx \quad . \tag{2.1}$$

"α" is the weight given to revenue raised in the welfare function, and is assumed to be non-negative. $P(x,q)$ is the price paid by the consumer for purchasing a unit of the good of quality q. sx is the revenue earned by government from the scheme outlined above, where s is determined so as to cause the monopolist to sell only the desired level of imports. Both x and q, of course, depend on s as well.

The effect on national welfare of a unit decrease in the level of imports from the free trade levels, caused by a quota may be decomposed

into three parts — the effect via output, the effect via quality, and the effect via revenue. Define Δs as the specific tariff required to lower imports by one unit. Then the change in welfare due to a reduction of imports by one unit is given by:

$$(2.2) \qquad \Delta W\Big|_{Q} = \frac{\partial W}{\partial x}\frac{\partial x}{\partial s}\Delta s + \frac{\partial W}{\partial q}\frac{\partial q}{\partial s}\Delta s + \frac{\partial W}{\partial s}\Delta s$$

Using equation (1.11) and setting $\Delta x = -1$, yields:

$$(2.3) \qquad \Delta s = \frac{-|H|}{(P_{qq} - C_{qq})x} .$$

As the monopolist maximizes profits, $-P_x x = (P - C)$. Differentiating (2.1), and using (1.9), (1.11), and (1.12) and evaluating welfare changes about $s = 0$ allows equation (2.2) to be re-written as:

$$(2.4) \qquad \Delta W\Big|_{Q} = -(P - C) + (U_q - P_q x)\frac{(xP_{xq})}{(P_{qq} - C_{qq})x} - \frac{|H|\alpha}{(P_{qq} - C_{qq})} .$$

This expression shows that there is always an adverse effect on welfare via output of a quota. This is expected, as a monopolist produces too little output for any given quality level, and a quota aggravates this distortion.

Less expected is the fact that as P_q is assumed to be monotonic in output, there is <u>always</u> a beneficial effect on welfare via quality and revenue. Notice that:[6]

$$(2.5) \qquad U_q(\hat{x},\hat{q}) - P_q(\hat{x},\hat{q})\hat{x} = \hat{x}\left[\frac{1}{\hat{x}}\int_0^{\hat{x}} U_{xq}(v,\hat{q})dv - P_q(\hat{x},\hat{q})\right]$$

$$= \hat{x}\left[\frac{1}{\hat{x}}\int_0^{\hat{x}} P_q(v,\hat{q})dv - P_q(\hat{x},\hat{q})\right] .$$

If P_{xq} is positive, the average valuation of quality increments must be below P_q, so that (2.5) is negative. Similarly, if P_{xq} is negative, (2.5) must be positive. As $P_{qq} - C_{qq} < 0$ by second order conditions, the second term in (2.4) is always positive. When $P_{xq} < 0$, the monopolist is producing too low a quality level (as $\partial W/\partial q > 0$), and a quota raises quality, thus raising welfare. If $P_{xq} > 0$, too high a quality level is being produced ($\partial W/\partial q < 0$), and a quota lowers quality, which again raises welfare.

The effect on welfare, via revenue, is always beneficial as the sale of licenses transfers some of the monopolist's profits to the national government.

Now consider the effect on welfare of an import equivalent tariff, $\Delta W\big|_T$. National welfare is given by:

$$W = U(x,q) - P(x,q)x + \alpha t P(x,q)x . \tag{2.6}$$

Differentiating (2.4) gives:

$$\Delta W\big|_T = \frac{\partial W}{\partial x}\frac{\partial x}{\partial t}\Delta t + \frac{\partial W}{\partial q}\frac{\partial q}{\partial t}\Delta t + \frac{\partial W}{\partial t}\Delta t , \tag{2.7}$$

where (1.8) can be used to define the import equivalent tariff rate, Δt, as being:

$$\Delta t = \frac{-|H|}{(P_x x + P)(P_{qq} - C_{qq})x - P_{xq}xP_q} . \tag{2.8}$$

Using (1.8) and (1.9) allows (2.7) to be written as:

$$(2.9)\qquad \Delta W\Big|_T = -(P - C) - \frac{(U_q - P_q x)\left[(2P_x + xP_{xx})P_q - (P_x x + P)P_{xq}\right]}{\left[(P_x x + P)(P_{qq} - C_{qq}) - P_{xq} x P_q\right]}$$

$$- \frac{\alpha(P \cdot x)\,|H|}{\left[(P_x x + P)(P_{qq} - C_{qq})x - P_{xq} x P_q x\right]} .$$

The effect on welfare via output of an import equivalent tariff and quota are identical. The effect of the tariff on welfare via quality is beneficial if $P_{xq} > 0$, as then the tariff lowers quality and, as quality is at too high a level, this is beneficial. If $P_{xq} < 0$, quality is set at too low a level, but the tariff may lower it further, and the effect of a tariff on welfare via quality may be harmful. The effect via revenue raises welfare if a positive tariff is required to lower imports, while it lowers welfare if a subsidy is required.

Using (2.9) and (2.4) allows us to compare a quota to the import equivalent tariff. The resulting expression is somewhat formidable.

$$(2.10)\qquad \Delta W\Big|_Q - \Delta W\Big|_T = \Big[(U_q - P_q x)\Big\{\frac{P_{xq}}{(P_{qq} - C_{qq})}$$

$$+ \frac{\left[(2P_x + xP_{xx})P_q - (P_x x + P)P_{xq}\right]}{\left[(P_x x + P)(P_{qq} - C_{qq}) - P_{xq} x P_q\right]}\Big\}\Big]$$

$$- \alpha\left\{\frac{|H|}{(P_{qq} - C_{qq})} - \frac{P\,|H|}{\left[(P_x x + P)(P_{qq} - C_{qq}) - P_{xq} P_q x\right]}\right\}$$

The first term in brackets compares quality effects on welfare, while the second term in brackets compares their revenue effects. The

importance of revenue raised by the restrictions is given by the size of α. If $\alpha = 0$, the first term in brackets will determine the ranking of a tariff and its import equivalent quota, while if α is large, the second term will determine this ranking.

Expanding the terms in the first brackets shows that the expression in the first brackets (denoted by $(\Delta W_Q - \Delta W_T)\big|_q$ as it is the comparison between a quota and tariff on the basis of their quality effects alone) equals:

$$(2.11) \qquad (\Delta W_Q - \Delta W_T)\big|_q = \left\{\left(\frac{dx}{dt}\right)^{-1} \frac{P_q}{(P_{qq} - C_{qq})}\right\} (U_q - P_q x) .$$

Consider the sign of this where $P_{xq} < 0$ and $\frac{dx}{dt} < 0$, so that a quota leads to quality upgrading and an ad-valorem tariff lowers imports, the "normal" case on the basis of casual empiricism. In this case, then the above expression is positive and a comparison of a tariff and quota on the basis of their effects on welfare via quality alone goes in <u>favor</u> of quotas. If $P_{xq} > 0$ (which implies that $\frac{dx}{dt} < 0$) or $\frac{dx}{dt} > 0$, (which implies $P_{xq} < 0$), the reverse is true.

The intuition behind this is clear from Diagram 1.2(a) and (b). Consider first the case where $P_{xq} < 0$, portrayed in Diagram 1.2(a). A quota and an import equivalent tariff give rise to equilibrium points such as C and A if $\frac{dx}{dt} < 0$, and C and A' if $\frac{dx}{dt} > 0$. As the monopolist sets quality too low when $P_{xq} < 0$ and as C lies at a higher utility level than A, a quota dominates a tariff in the normal case. If $\frac{dx}{dt} > 0$, a tariff dominates a quota as A' lies above C. If $P_{xq} > 0$ (Diagram 1.2(b)), then a tariff dominates a quota as quality is set too high and C lies above A.

Expanding the terms in the second set of brackets in (2.10) gives the ranking of an import equivalent tariff and quota in terms of their effects on welfare via revenue alone. This is denoted by $\Delta W_Q - \Delta W_{T_R}|$. Thus:

$$(2.12) \qquad \Delta W_Q - \Delta W_{T_R}| = -\left[\frac{dx}{dt}\right]^{-1} x \left[\frac{P_x x(P_{qq} - C_{qq}) - P_{xq}P_q x}{(P_{qq} - C_{qq})}\right] .$$

Notice that in the normal case this expression is negative. The results so far are conveniently summarized in Proposition 1.

Proposition 1: Comparisons between tariffs and quotas which are import equivalent depends on the importance of revenue raising in the national welfare function as given by α, as well as on the nature of preferences over output and quality. For the "normal" case $(\frac{dx}{dt} < 0, P_{xq} < 0)$, the choice of policy depends only on the weight assigned by α to revenue considerations in the national welfare function. If α is very large, so that revenue considerations are of great importance, a tariff always dominates a quota. If revenues are given a small enough weight in the national welfare function, so that α is close to zero, then quotas always dominate tariffs.

Another special case allows us to focus on the role of P_{xq} in this comparison. Notice that if P_q is independent of x, P_{xq} and $U_q - P_q x$ are equal to zero. Hence, there is no effect on welfare, via quality of either measure. Therefore, all comparison must be on the basis of revenue effects only. The revenue effects of a tariff in this case are preferable to those of the quota as (2.12) reduces to:

$$\Delta W_Q - \Delta W_T = -\left[\frac{(P_x)^2 x^2 (2P_x + xP_{xx})}{P_x(P_x x + P)}\right] . \tag{2.13}$$

Second order conditions ensure that $2P_x - xP_{xx} < 0$. This ensure that (2.14) is negative, so that the tariff is preferable to the quota. Thus we have shown that:

Proposition 2: If the valuation of an increment in quality, P_q, is independent of output, so $P_{xq} = 0$, then a tariff always dominates an import equivalent quota.

2.4 Tariffs vs. Quotas: A Special Case:

Next consider the case where demand is for services of the good produced. Higher quality is identified with greater durability, and hence a greater quantity of embodied services. Rodriguez and Santoni and Van Cott discuss how quotas and tariffs can be ranked in such a model in the presence of competition.

The assumption behind this specification is that utility is a function only of the amount of services provided. Thus, if $S = xq$ is the level of services, we assume

$$U(x,q) = \Gamma(xq) \ .$$

Thus,

$$P(x,q) = q\,\Gamma'(xq) = qG(xq)$$

is the inverse demand function for the good of quality q. Dividing by q gives $G(xq) = \frac{P(x,q)}{q}$, as the inverse demand function for services. The monopolist maximizes:

$$[P(x,q)-C(q)]x = [G(S) - \frac{C(q)}{q}]S \ .$$

Thus, q is chosen independently of S, so as to minimize $\frac{C(q)}{q}$, so that quality choice is independent of demand conditions. Notice that as a consequence an ad-valorem tariff does <u>not</u> affect the choice of q. A quota, however, does affect the choice of q.[7]

For notational convenience, define ω to be $2G' + SG''$. Notice that $\omega < 0$ as $\frac{\partial^2\pi(S,q)}{\partial S^2} < 0$ by the second order conditions for a maximum.

It is easy to show that for this model:

$$\frac{dx}{dt} = \frac{-xqP_qC_{qq}}{|H|} < 0 \,, \tag{2.14}$$

so that a tariff lowers output,

$$\frac{dq}{dt} = 0 \,, \tag{2.15}$$

so that a tariff has no effect on quality choice, and

$$\frac{dq}{ds} = \frac{-xq\omega}{|H|} > 0 \,, \tag{2.16}$$

so that quality is upgraded due to a quota.

We know that the effect via quality on welfare of a quota is always beneficial, and in this case, a tariff has no effect on welfare via quality. Thus, their comparison in terms of their effects on welfare via quality is given by:

$$\Delta W_Q - \Delta W_T\Big|_q = \Delta W_Q\Big|_q = (-x^2G'q)\,\frac{q\omega}{(x\omega - C_{qq})} > 0 \,. \tag{2.17}$$

The revenue effect, however, goes in the opposite direction. This is shown by using the general expression in (2.10) to be

$$\Delta W_Q - \Delta W_T\Big|_R = \alpha\left\{\frac{|H|\,[-q^2xG'C_{qq} - Gxq\omega]}{(qP_qC_{qq})(x\omega - C_{qq})}\right\} < 0 \,. \tag{2.18}$$

The net effect may be computed, when $G'' = 0$, and $\alpha = 1$ to be in

favor of tariffs, as

$$(2.19) \qquad \Delta W_Q - \Delta W_T = \frac{2(xqG')^2}{(P_{qq} - C_{qq})P_q}\,[qC_{qq} + G - SG'] < 0$$

Thus, we have shown the following:

Proposition 3: If demand for the good is derived from services produced by the good and higher quality good produce more services, then if $\alpha = 0$, so that revenue considerations are unimportant, a quota is preferable to an import equivalent tariff. If α is large, and revenue considerations are of primary importance, a tariff is preferable to and import equivalent quota. If both are equally important, and demand for services is linear, a tariff is preferable to the import equivalent quota. Notice that this is the opposite of the Rodriguez result where a quota was preferable to a tariff.

This concludes the comparison of tariffs and quotas which are import equivalent. We turn now to a comparison of each of these policies with import equivalent quality controls.

2.5 Quality Controls vs. Tariffs and Quotas:

Any comparison of a quality control with a tariff or a quota will be naturally biased in favor of the tariff and quota, as these measures generate revenue. Therefore, I will only compare them in their effects on welfare via quality, denoted by $(\Delta W_q - \Delta W_Q)\big|_q$.

$$(2.20) \qquad \Delta W_Q\big|_q = \frac{\partial W}{\partial q}\Delta q + \frac{\partial W}{\partial x}\frac{dx}{dq}\Delta q$$

where $\Delta q = \frac{2P_x + xP_{xx}}{P_{xq}x}$ is the quality change that induces a unit decrease in output.

$$(2.21) \qquad \Delta W_q \Big|_q = (U_q - P_q x)\left(\frac{2P_x + xP_{xx}}{P_{xq}x}\right) - (P - C) \ .$$

Notice that quality controls always raise welfare via their effect on quality. Comparing a quality standard to a quota gives,

$$(2.22) \qquad (\Delta W_Q - \Delta W_q)\Big|_q = (U_q - P_q x)\left[\frac{(P_{xq})x}{(P_{qq} - C_{qq})x} - \frac{(2P_x + xP_{xx})}{P_{xq}x}\right]$$

$$= \frac{-(U_q - P_q x)}{P_{xq}x} \frac{[\,|H|\,]}{(P_{qq} - C_{qq})x} < 0$$

In their effects on welfare via quality alone, quality standards are superior to quotas. The intuition behind this result may be understood by refering to Diagram 1.1. If $P_{xq} < 0$, higher welfare arises from higher q and higher x, given by the shaded region in Diagram 1.1a. Similarly if $P_{xq} > 0$, higher welfare arises from lower q and higher x, given by the shaded region in Diagram 1.1b. A quota leading to a decrease in output of a unit leads to equilibrium at a point like A. A quality control that lowers output by as much, leads to equilibrium at point B. The welfare at B is always higher than that at A.

Next, I compare a tariff and the import equivalent quality control. Again, only their effects on welfare via quality are compared. Note

that we already have a result in the case where demand is only for services provided. In this case, as tariff do not affect quality choice, and as the effect on welfare via quality of quality controls is always beneficial, quality controls dominate tariffs in their effects on welfare via quality.

The comparison for the general case is made in equation (2.23 .

$$(2.23) \qquad (\Delta W_T - \Delta W_q)\Big|_q =$$

$$(U_q - P_q x)\left\{\frac{-[(2P_x + xP_{xx})P_q - (P_x x + P)P_{xq}]}{[P_x x + P)(P_{qq} - C_{qq}) - P_{xq} x P_q]} - \frac{(2P_x + xP_{xx})}{P_{xq} x}\right\}$$

$$= \left[\frac{-(U_q - P_q x)}{P_{xq} x^2}\right] \frac{|H|\,(P_x x + P)}{[(P_x x + P)(P_{qq} - C_{qq}) - P_{xq} x P_q]} \gtrless 0$$

as $\frac{dx}{dt} \gtrless 0$. If $\frac{dx}{dt} < 0$, so a tariff reduces output, a quality control is better than an import equivalent tariff. If $\frac{dx}{dt} > 0$, then a subsidy is required to reduce output, and a tariff is better than quality control. Again, the intuition is apparent from Diagram 1.2. Consider first the case where $P_{xq} < 0$ and $\frac{dx}{dt} < 0$, so that a tariff is required to lower imports. It is easy to see that the tariff shifts both $x(q)$ and $q(x)$ towards the origin as in Diagram 1.2(a). A and B are achieved by a tariff and a quality control that are import equivalent. As the quality chosen by the monopolist is too low, and as B lies directly above A, the quality control must dominate the tariff in its effect on welfare via quality alone. Similarly, if $\frac{dx}{dt} > 0$, then a subsidy would be required to lower output, and A' would be the equilibrium under the import equivalent tariff. A' lies directly above B and thus the tariff would

dominate the import equivalent quality control in terms of its effects on welfare via quality. Similarly, if $P_{xq} > 0$, as in Diagram 1.2(b), the quality control dominates the tariff as A (the tariff point) lies directly above B (the quality control point). As $P_{xq} > 0$, the monopolist sets quality at too high a level, so that the comparison between A and B on the basis of quality effects alone goes in favor of the quality control.

The results of this subsection may be summarized as follows:

Proposition 4: When revenue considerations are unimportant ($\alpha = 0$), then quality controls dominate import equivalent quotas. In addition, if imports fall due to an ad-valorem tariff, they dominate import equivalent tariffs as well.

Quotas are widely used in order to restrict trade. However, the common feeling is that tariffs are a superior way of restricting trade. If the quality aspect is supressed in the above framework, it is easy to see that tariffs dominate quotas. However, when quality aspects are introduced, a tendency emerges for quotas to dominate tariffs on the basis of their quality effects, and their ranking depends on the importance of such effects, relative to other effects. In other words, quotas become more desirable instruments, compared to tariffs, when their effects on quality are taken into account. Similar comparisons of policies which are equivalent in terms of revenue or foreign exchange use can be made with similar results.

Conclusion

Although the effects of trade restrictions with endogenous quality have been previously studied, the specification of the structures to be analyzed have been particularly suited to the paradigm of perfect competition.

In an imperfectly competitive world, a large number of questions arise which do not have corresponding analogues in a competitive world. In order to study such question, it is important to develop simple models to capture, possibly in isolation, the factors which might be important in answering such questions. This paper is to be viewed as an attempt at doing just this.

The purpose of this paper was to analyze the effects of different kinds of trade restriction on the quality chosen by a foreign monopolist, and to examine the relative desirability of alternative policies in attaining a given non-economic objective. The presumption (based on the Swan model) that quotas raise quality while ad- Valorem tariffs leave quality unaffected was shown to be unfounded. Moreover, their effects were shown to depend on the valuation of quality increments by marginal as compared to all consumers - i.e. to demand conditions rather than to cost conditions as in the Swan model. A way to compare "infinitesimal" equivalent powers was developed. The use of this technique showed that when import equivalent policies were compared in terms of their quality effects, tariffs were dominated by quotas in the "normal" case and not <u>just</u> in the Swan model. In the other cases (considered to be somewhat special), it was shown that these rankings could be reversed.

Footnotes

[1] Advertising costs for example are often thought of as being fixed and product specific.

[2] The effects of trade restrictions and their comparisons are all evaluated at the free trade levels throughout the paper. In addition, in order to be able to simplify the analysis I assume throughout that derivative of the inverse demand function with respect to quality is a monotonic function of output.

[3] Spence (1976).

[4] As an example one might consider the following. There is a continuum of consumers, indexed by θ, with reservation price $u(\theta,q)$. All consumers purchase one unit of the commodity, or none. Consumers are distributed by $f(\theta)$. $u_\theta(\theta,q) > 0$. Demand is then given by $1-F(\theta^*(p,q))$, where θ^* indexes the marginal consumer. $P(x,q)$ represents the corresponding inverse demand function. Messy calculations show that as expected, if high θ consumers value increments in quality more than low θ ones, so that $u_{\theta q} > 0$, then $P_{xq} < 0$ as:

$$P_{xq}(x,q) = \frac{-u_{\theta q}[\theta^*(P(x,q),q),q]}{f(\theta^*(P(x,q),q))} .$$

[5] See Rodriguez (1979) and Santoni and Van Cott (1980) for details.

[6] I assume $U_q(0,\hat{q}) = 0$ for all $\hat{q}$.

[7] For this model, simple differentiation shows that:

$$P_q = G + SG' = \frac{(P_x x + P)}{q} ;$$

$$P_x = q^2 G' ;$$

$$P_{xx} = q^3 G'' ;$$

$$P_{xq} = q(2G' + SG'') = q\omega ;$$

$$P_{qq} = x(2G' + SG'') = x\omega ;$$

$$U_q - xP_q = - x^2 q G' ;$$

$$P_{xx} + 2P_x = \omega q^2 ;$$

and $$|H| = - C_{qq} x q^2 \omega .$$

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Diagram 1.1(a)

($P_{xq} < 0$)

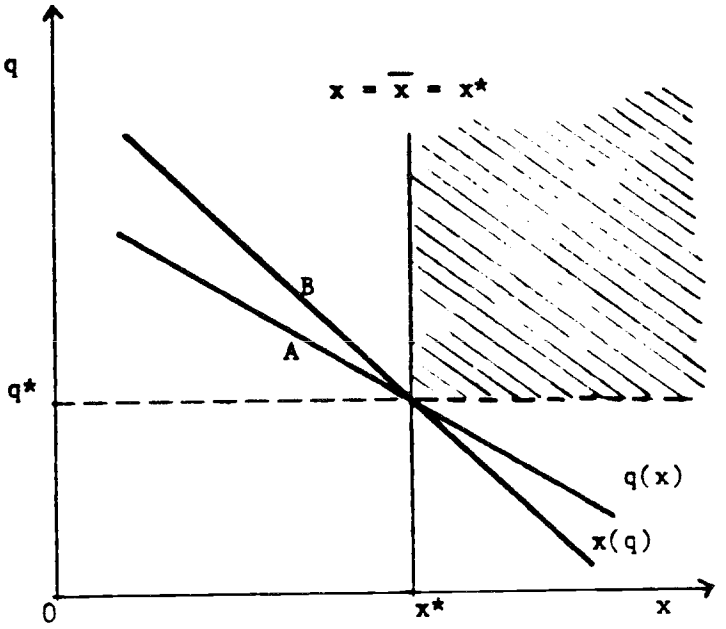

Diagram 1.1(b)

($P_{xq} > 0$)

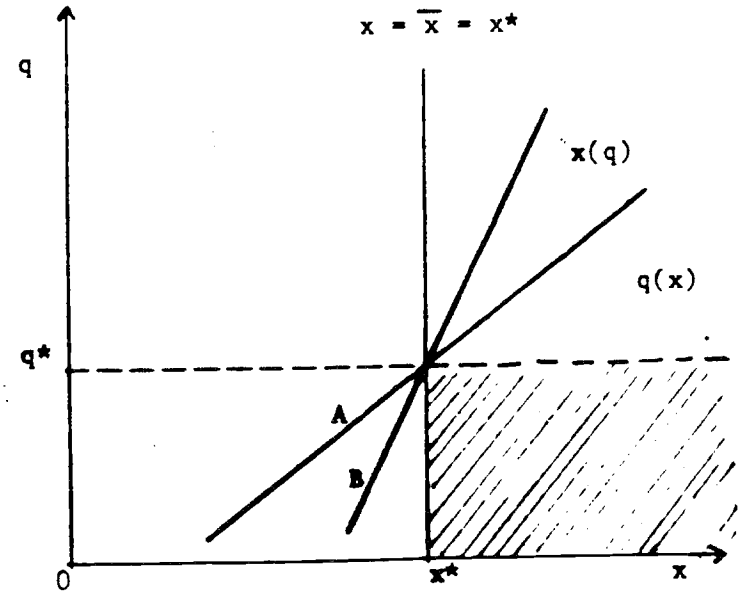

Diagram 1.2(a)

($P_{xq} < 0$)

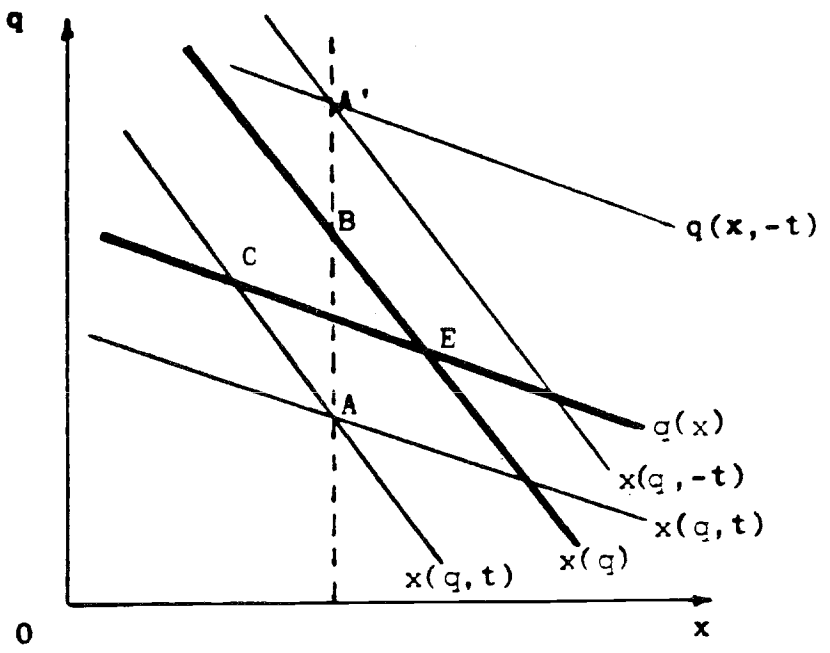

Diagram 1.2(b)

($P_{xq} > 0$)

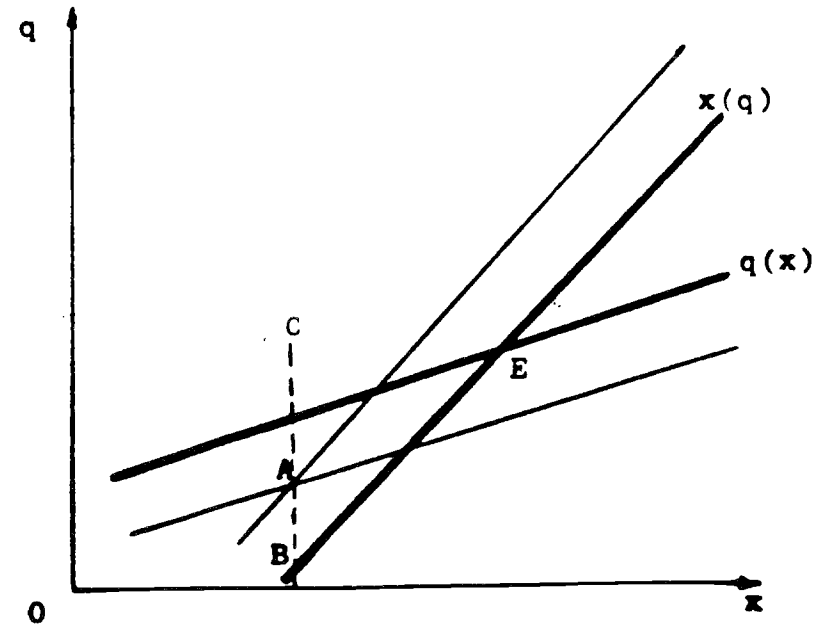

Diagram 2.1(a)

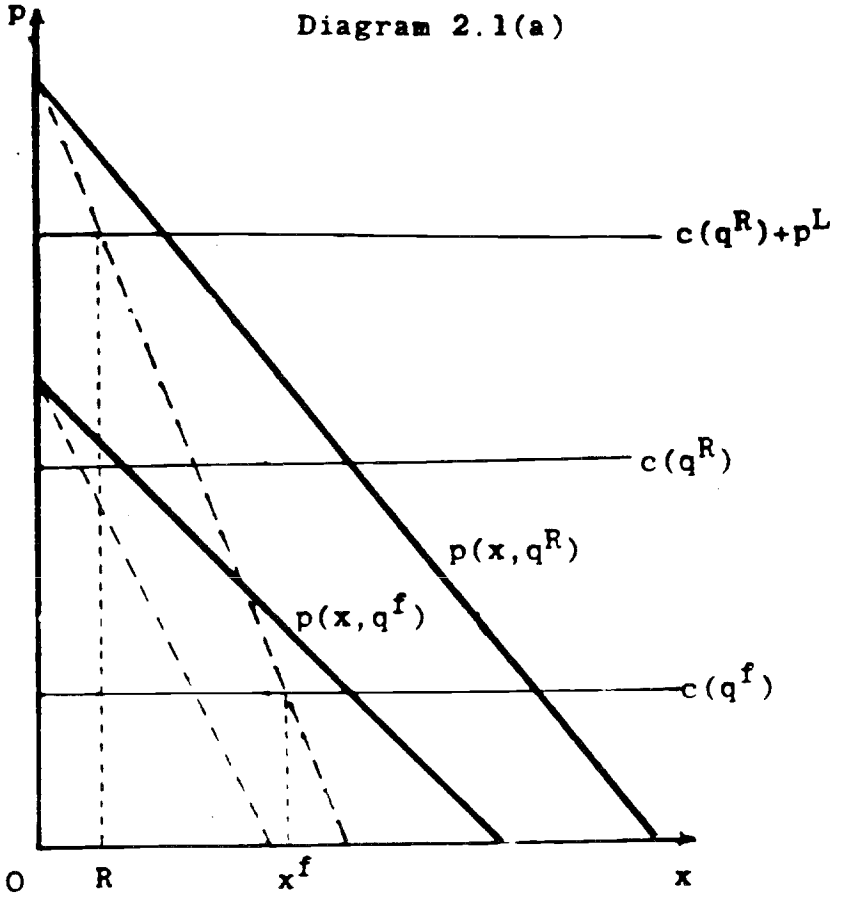

Diagram 2.1(b)